National Park Service - Southwest Alaska Network
Inventory & Monitoring Program

Monitoring Visitor Use and Associated Impacts in the Southwest Alaska Network Parks

Southwest Alaska Network

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March 2005

Report Number: NPS/AKRSWAN/NRTR-2005/01
Cooperative Agreement Number: H9855040020

Funding Sources:
Inventory & Monitoring Program, National Park Service
Environmental Studies Department, St. Lawrence University

File Name:
MonzC_2005_SWANVIMPhase1Report_590331.doc

Abstract:
The scope and extent of visitor use and resource impacts in the Southwest Alaska Network Parks (SWAN) was investigated as the first step in developing visitor impact monitoring protocols. Thorough scoping, including managers interviews, site visits and documentation of resource impacts revealed several visitor impact issues across SWAN Parks, namely impacts to soil and vegetation, wildlife disturbance and noise associated with aircraft and motorboat use. Sixteen possible vital signs measures were identified as possible monitoring indicators of visitor impact and use. These vital signs measures were prioritized based on fourteen criteria and ranked as to their priority for further development. The second phase of this project will develop monitoring protocols for selected vital signs.

Recommended Citation:
Monz, Christopher A. 2005. Monitoring Visitor Use and Associated Impacts in the Southwest Alaska Network. USDI National Park Service. Anchorage, AK. 58 pg.

Topic(s): Monitoring, Visitor Use, Visitor Resource Impacts

Theme key words: Monitoring, Alaska, Southwest Alaska National Parks, Visitor Impacts, Visitor Use, Recreation, Wilderness

Place key words:
Alaska, Arctic Network, Central Alaska Network, Southeast Alaska Network, Southwest Alaska Network

Acronyms:

ALAG	Alagnak Wild River
ANIA	Aniakchak National Monument & Preserve
I&M	Inventory & Monitoring (Program)
KATM	Katmai National Park & Preserve
KEFJ	Kenai Fjords National Park
LACL	Lake Clark National Park & Preserve
NPS	National Park Service
PWS	Prince William Sound
SWAN	Southwest Alaska Network
VERP	Visitor Experience and Resource Protection
VIM	Visitor Impact Monitoring

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I- INTRODUCTION

A. Project Background

A research project, "Monitoring Visitor Use and Associated Impacts in the Southwest Alaska National Parks" was initiated in May 2004 as a two-phase study to test candidate measures for future visitor impact monitoring programs at five park units managed by the National Park Service (NPS). These areas are as follows:

Alagnak Wild River
Aniakchak National Monument and Preserve
Katmai National Park and Preserve
Kenai Fjords National Park
Lake Clark National Park and Preserve

This "Phase 1 Project Report" summarizes the findings from the first phase of the project and includes 1) identification of network wide monitoring questions and major visitor resource impact concerns; 2) a summary of the scoping results (manager interviews and site visits); 3) photographic and spatial documentation of visitor impacts and management issues (GIS files provided); 4) conceptual models of visitor impacts in coastal parks and 5) a prioritized list of candidate impact monitoring variables; 6) a synopsis of NPS Vital Signs sampling techniques and their relevance to SWAN visitor monitoring and 7) preliminary conclusions on specific monitoring recommendations and future research directions. This report also contains (in appendices and electronic files) summaries of field activities conducted during the summer 2004 and a summary of a managers scoping workshop held in May 2004.

B. Network-wide monitoring questions to be addressed by visitor use and impact monitoring

Considerable research has been conducted over the last 40 years on the consequences of recreational activities on natural resource conditions (Leung and Marion, 2000). This project continues to build on this knowledge in an effort to address the following long term monitoring questions:

- Which of the SWAN Parks are in need of visitor use monitoring and visitor impact monitoring programs?
- What are the management areas of critical concern where current or potential visitor activities threaten resource quality and compromise resource protection objectives?
- In areas of critical concern, how is the type, amount and distribution of visitor use changing over time?

- In areas of critical concern, what is the type and extent of visitor impacts to soil, vegetation, water and wildlife resources and how are these impacts changing over time?

This project is part of the NPS Vital Sign Program that was created for monitoring conditions of important natural resource variables indicative of ecosystem health and resource integrity. Visitors to SWAN Parks are engaged in various recreation activities which have the potential generate some level of impact. While visitor activity impacts may occur in many park areas, impacts occurring within sensitive, natural/pristine or protected zones are of most concern because of the ecological and social value of these areas. Since SWAN parks are primarily designated and managed at the highest level of resource protection (e.g., wilderness, preserve, etc.) monitoring the trends of use and impact is particularly important (Cole 1997). In addition, monitoring visitor impacts in these areas is consistent with the objectives of the Vital Sign Program as the impacts may constitute a significant threat to ecological health. The approach adopted by this study is similar to monitoring approaches in other NPS areas and parallels efforts in other NPS Vital Signs Networks (Milstead and Stevens 2003, Monz and Leung 2003)

C. Summary of Relevant Literature

Considerable research, conducted over the last 40 years, has demonstrated the relationships between visitor use and resource impact. The scientific study of these relationships is often referred to as *Recreation Ecology*. Recent efforts have reviewed and synthesized this information (e.g., Leung and Marion 2000; Hammitt and Cole 1998) and this knowledge forms a basis for this study. Several fundamental principles can be generalized from this body of literature including:

1. Recreation activities can and often will directly affect the soil, vegetation, wildlife, water and air components of ecosystems
2. Ecosystem attributes (i.e., structure and function) can ultimately be affected by visitor use impacts given the interrelationships between ecosystem components
3. For a given finite space, the relationship between impact and use is often curvilinear, with the majority of impact occurring with initial use. This is particularly the case with impacts to vegetation and soils.
4. Although some generalizations apply, resistance and resilience to visitor use disturbance is ecosystem specific
5. Although the amount and distribution of use is important from an impact standpoint, visitor behavior and practices play perhaps a more significant role determining the amount of impact

Given these principles, recreation ecology studies of two types are generally performed in parks and protected areas in an effort to assist managers in the avoidance and mitigation of visitor impacts. *Experimental studies* (e.g., Monz 2002, Cole and Monz 2003) examine causal relationships between use type and intensity and ecosystem-specific components. These studies employ carefully

controlled experimental designs and can determine the levels of visitor use which a given ecosystem (or ecosystem component) can tolerate. *Monitoring and assessment* studies (e.g., Marion 1991, Monz and Twardock 2004) are perhaps more common as managers often find them to be of considerable utility. These studies assess and monitor the location and extent of visitor use and resource impacts. Conducted over the long term, these studies provide an initial assessment of the current resource conditions, the trends of how impacts are changing over time, and an evaluation of the effectiveness of management actions.

Considerable literature also exists on the management of visitor resource impacts (e.g., Hammitt and Cole 1998; Manning 1999). The development of specific, accurate monitoring indicators is considered fundamental to the management process and an essential process in various management frameworks (Manning 1999). As such, recreation ecology studies are an integral component of management framework approaches (e.g., Visitor Experience and Resource Protection (VERP) Framework) in assisting in the development of monitoring indicators and in measuring said indicators over time to determine if standards have been violated (NPS 1997).

More broadly, the NPS has recently initiated a program of "vital signs monitoring" to develop scientifically sound information on the status and trends of park ecosystems. Vital signs, sometimes referred to as ecological indicators, are defined as measurable features of the environment that provide insights into the state of an ecosystem. The NPS strives to assess and monitor the health of park resources in order to manage threats proactively. Monitoring vital signs provides the foundation for this approach by evaluating efficacy of management actions and by warning of impending threats to park resources (Fancy, 2003).

Recently this vital signs approach has been applied to the selection and ranking of indicators of visitor use and impacts (Monz and Leung 2003). This approach seems particularly applicable to the issue of visitor impacts since 1) as the recreation ecology literature indicates, visitor impacts can be significant ecosystem stressors and 2) vital signs indicators can help fulfill and complement VERP framework needs.

Visitor Impacts in Alaskan Environments

Alaska National Parks are arguably some of the last remaining true wilderness areas in the world. These parks are large enough to allow natural process to operate freely and are far enough from population centers and human habitation to exhibit relatively little in the way of human caused disturbance (Bennett et. al., 2003). It is arguable that low use wilderness and "pristine" areas such as these will benefit more from the management and monitoring of visitor use and impact than high use areas because of the aforementioned curvilinear nature of the relationship between use and impact (Generalization 3 above, Hammitt and Cole 1998, Cole 1997).

To date, the information on the mechanisms and trends of visitor impacts in Alaska is a small, albeit significant body of literature. Looking broadly at Alaskan environments, noteworthy studies have been conducted on trampling disturbance in arctic and sub-arctic ecosystems (Monz 2002; Reid and Schreiner 1985), camping impacts in coastal environments (Monz and Twardock 2004) and disturbance of wildlife such as bald eagles (Steidl and Anthony 1996) and Alaskan brown bear (Smith 2002).

Visitor Impact in SWAN Parks and Related Areas in Alaska

Visitor impact studies have been conducted in three of the five SWAN Parks and are in the form of both NPS internal reports and in the published scientific literature (Table 1). The latter category—journal literature—currently consists of only a handful of studies. Across all parks, studies have primarily addressed the effects of hiking and camping on soils and vegetation (e.g., Bryden 2002, Tetreau 2000 c, Ulizio and Goodglick 1999) and the consequences of visitors, both specific activities and general human presence, on brown bears (e.g., Braaten and Gilbert 1986 Jacobs and Schloeder 1992, Smith 2002, Smith and Johnson 2004). In general the studies that have examined soils and vegetation have been primarily monitoring and assessment approaches using established sites, transects and trails as the unit of analysis. Initial assessments of campsite conditions have been conducted at KEFJ (Martin 2004, personal communication) and LACL (Goodglick and Ulizio 1999). Vegetation loss has been assessed in adjacent areas near the Exit Glacier and Harding Icefield trail in KEJF (Bryden 2002, Tetreau 2002 c). Although these assessments have been conducted, it appears that significant amount of these data have not been analyzed or published (Martin 2004, personal communication).

In contrast, the wildlife studies, particularly the examinations of the consequences of human presence on brown bears (*Ursus arctos*), have been exclusively experimental studies with extensive observation time and analysis (e.g., Smith 2002, Smith and Johnson 2004). In these studies bears altered their temporal and spatial use of the Kulik River (KATM) to avoid human presence. The majority of the times when bear-human interactions took place it was due to humans venturing into areas of high bear use as opposed to bears seeking out areas of high human activity. These studies suggest that as long as areas along the river remain devoid of humans, bears will seek these to feed on salmon undisturbed. Furthermore, these results point to the importance of understanding the spatial extent of human use as an important indicator of potential impact on bear populations.

Table 1. Research Categories and Selected Examples of the Visitor Impact Research in SWAN and Related Areas in Alaska

Research Theme	Study	Location	Visitor Type	Ecological Component	Variables measured
Activity specific, ecological component specific	Braaten and Gilbert (1986)	KATM- Brooks River	Angling	Brown Bears	Habituation
	Jacobs and Schloeder (1992)	Kenai Peninsula- Russian River trails	Hiking	Brown Bears	Encounters
	Bryden (2002)	KEJF- Exit Glacier, Upper Loop Trail	Hiking	Vegetation Loss	Percent cover of vascular plants, lichens and mosses
Activity Specific, Ecological component general	Monz and Twardock (2004)	PWS	Camping	Coastal wildland	Size of impacted area, vegetation cover, soil & root exposure, litter, tree damage, fire sites, condition class
	Tetreau (2000)	KEJF- Exit Glacier	Snowmobiling	Glacial Moraine	N/A
	Jope and Welp (1987)	KATM- American Creek	Jet Boat Use	River and environs	Turbidity Vegetation loss Bank Erosion
	Del Vecchio and Brennan 1992	KATM- Bay of Islands	Camping	Coastal wildland?	Photopoints, fire rings, human waste, condition class, mapping
	Tetreau (2002)	KEJF-Harding Icefield Trail	Hiking	Glacial Moraine and adjacent areas	N/A
	Ulizio and Goodglick (1999)	LACL	Camping	LACL ecosystems	Condition Class…?

Table 1. Continued

Research Theme	Study	Location	Visitor Type	Ecological Component	Variables measured
Activity general, Ecological component specific	Dean (1968)	KATM- Brooks Camp	Human Presence	Brown Bears	Bear-Human interactions
	Olson and Squibb (1991)	KATM- Brooks River	Human Presence	Brown Bears	Bear-Human incidents, aggressive behavior.
	Smith (2002)	KATM-Kulik River	Human Presence	Brown Bears	Displacement of bears due to human presence
	Smith and Johnson (2004)	KATM- Kulik River	Human Presence	Brown Bears	Displacement, habituation

Visitor Use Assessment in SWAN Parks and Related Areas

Various studies have been conducted at several of the SWAN parks examining visitor use numbers, types and trends (Table 2). These studies have focused on three of the parks LACL, KEFJ and KATM. One published study has been conducted in PWS and is mentioned here due to the use similarities with coastal areas of KEFJ. These studies are most helpful for this work by providing examples of existing use estimation and sampling techniques. For example, work in PWS relied on the use of outfitter surveys to estimate total use and use by geographic area (Twardock and Monz 2000). Oberlatz and Otto (1998) counted aircraft flights through Lake Clark pass as an estimate of total use activity and Tetreau (2000) examined cabin rental reservations. It is likely that multiple methodologies, as above, will be needed for accurate use estimation in most SWAN Parks.

Table 2. Examples of visitor use studies in SWAN Parks and related areas In Alaska

Study	Location	Visitor Type	Methodology	Variables measured
Jalone (2002)	LACL	General visitors to Silver Salmon Creek	N/A	Numbers of visitors
KEFJ Visitor Use Data(1981-2003)	KEFJ- General Park Locations	All Park Visitors	N/A	Visitor numbers at Exit Glacier, Visitor Center, etc., and via Tour Boats. Summarized by year
KEFJ (1999) Visitor Survey	KEFJ- Exit Glacier road, visitor center, Nature Trail, Harding Icefield Trail	General park visitors and hikers	Vehicle Counters, Trail counters	Number of people per day/hour, number per vehicle, vehicle type, trail use, kiosk use
Oberlatz and Otto (1998)	LACL- Lake Clark Pass	N/A	Aircraft Activity	Counts of flights through Lake Clark Pass
Tetreau (2000)	KEFJ Backcountry	Sea kayakers, motor and sailboat visitors, cabin visitors.	Cabin reservations and ranger contacts	Total numbers, group size, length of stay, destination area.
Twardock and Monz (2000)	PWS	Sea Kayakers	Outfitter surveys Direct counts Cabin rental records	Total Use Use by camping area Length of stay
Ulizio and Jakes (2001)	LACL	General visitors	N/A	Total numbers
Wilker (1990)	KATM- Brooks Camp	General visitors	Counts of visitors using the viewing platform	Total numbers

II-SCOPING METHODOLOGY

This report focuses specifically on Phase 1 of the SWAN visitor impact monitoring project, and as such the primary methodology involved a detailed scoping of the nature, extent and location of visitor use and resource impact. In order to gain knowledge on the extent of these concerns, this study employed 1) a manager's workshop where the scope of the project was detailed and impacts across all SWAN parks were discussed and summarized; 2) extensive site visits to areas of critical concern in the Parks during times of peak visitation (summer 2004) and 3) documentation of visitor use and impact issues utilizing digital photography

and differential corrected GPS. Due to time, budget and logistical limitations, ANIA was not visited during Phase 1 of this study.

Site visits during the summer of 2004 provided an opportunity for project staff to examine firsthand the locations and extent of established resource impact and to examine areas of known visitor use. Given that SWAN parks span an enormous area roughly equivalent to 3% of the Alaskan land mass (Bennett and others 2003), we relied on the knowledge of park staff to direct our observations to known areas of visitor use. Visiting each park gave us an opportunity to visit with park staff as a follow-up to the manager's workshop (appendix 1) and to meet new staff who were not present at the workshop (appendix 2).

Once on site, we visited both front and backcountry areas of established visitor use (Table 3), usually accompanied by park field staff. These visits were approximately one week in duration for each park. Independent of any previous site assessments conducted by the parks, we conducted a basic assessment of sites visited, obtained digital photos of impacts and collected location information using GPS (Trimble XM system). Post processing of these data generally resulted in 1-2 m accuracy. MediaMapper software (Trimble Corp.) was utilized to link GPS location and attribute data to the appropriate digital photos and the resulting product was exported to ArcView 3.3 (ESRI, Inc. Redlands, CA). Additional details on field procedures are listed in appendix 4, including list of attributes collected at each site. This information, while not extensively summarized here, will be used to inform the forthcoming protocol development stage of the project.

Table 3. Site visits during the 2004 field season

Park	Areas Visited	Dates of site visits
ALAG	Over flight of Alagnak River to the confluence with the Nonvianuk River	July 21st
ANIA	Not visited during 2004	
KEJF	Exit Glacier and Environs Aialik Bay Quicksand Cove McMullen Cove Pederson Lagoon	June 14-20
KATM	Brooks Camp Valley of 10,000 Smokes	July 20- 26th
LACL	Port Alsworth environs Tri Lakes area Lachbuna Lake	August 2-7

III- SUMMARY OF SCOPING RESULTS--MAJOR VISITOR IMPACTS

Visitors to SWAN parks are engaged in a wide variety of recreation activities, many of which have potential resource impact consequences (Table 4). These activities are generally the wilderness-based visitor use that one might expect in large Alaskan wilderness areas, with a few unique aspects. First, with the exception of KEFJ, none of the SWAN parks have road access from the major population and tourist centers in Alaska. Therefore, visitors to these parks arrive via air or boat charter, with most visitors staging extended stays from the towns such as Port Alsworth and King Salmon. In some cases, visitors fly directly to backcountry areas in the parks from Anchorage, with limited, if any contact with park staff. In general visitors pursue more recreational activities in the rocky beaches and shoreline (coastal) and the freshwater systems (lake and river) environments than in other environments (Table 4).

Table 4 Recreational Activities by Ecosystem Type in SWAN Parks

Visitor Activities	Ecosystem Type1					
	RBSL	BTLF	UPLF	TUND	FSWS	GENV
Water Based						
Kayaking	X				X	
Canoeing					X	
Rafting					X	
Fishing					X	
Power Boating	X				X	
Swimming						
Natural Resource Collection						
Nature Observation	X				X	
Subsistence Uses	X				X	
Land Based						
Backpacking		X	X	X		
Walking/Hiking		X		X		X
Camping	X	X	X	X	X	X
Hunting	X	X		X		
Lodge/Cabin Stays	X	X				
Mountaineering				X		X
Natural Resource Collection						
Nature Observation					X	X
Subsistence Uses	X	X	X	X	X	

1 Ecosystem Types: RBSL= Rocky Beaches and Shoreline, BTLF= Bottom Land Forests, UPLF= Upland Forests, TUND= Tundra, FSWS= Fresh Water Systems, GENV= Glacial/High Mountain Environments.

Table 5. Common Visitor Impacts to SWAN Parks

Impact issues1	Parks2				
	ALAG	ANIA	KATM	KEFJ	LACL
Campsites (visitor-created)	X	P	X	X	X
Cultural Resource Damage	X		P		P
Fire Rings / Scars	X		X	X	X
Human Waste Disposal Issues	P		P	P	P
Hunting/Fishing Camp Impacts	X				X
Illegal Harvesting of Natural Resources	U	U	U	U	U
Liter / Trash	P	P	P	P	P
Shoreline Habitat Damage	X		X	X	X
Soil Disturbance	X	P	X	X	X
Subsistence Use Impacts	P				P
Social Trails		P		X	X
Soundscape Disturbance (Noise)	X	P	X	X	X
Trampling Vegetation	X	P		X	X
Vandalism					
Water Contamination	P	P	P	P	P
Wildlife Disturbance			X	X	P
Bear			X		X
Moose				X	
Shorebirds			P	X	P

1 "X"= Known/Observed impact issue; "P"= Potential impact issue; "U" Status Unknown at present
2 Follows standard NPS abbreviations for parks

Managers are concerned with a wide range of impacts associated with visitation (Table 5). These impacts can be placed into two categories; 1) known, existing impacts, many of which were documented during the site visits and 2) potential impacts not identified directly by managers as a concern, but possible given the level and types of use at park areas observed. With the exception of ANIA, many of the impact concerns raised across the parks are typical issues regarding wilderness based recreation, such as the impacts to soils and vegetation from hiking and camping and visitor disturbance to wildlife. ANIA, with extremely low visitation (< 300 visitors per year) and durable volcanic soils is the exception, with an extremely low level of established impact. Therefore all impacts for ANIA are listed as potential, should use increase.

In the parks with established use and impact, several unique issues are present. First, managers raised only moderate concern with human waste disposal issues. SWAN parks are vast and relatively low use, so it would be reasonable to suggest that at present, little concern exists. There are however, backcountry areas in all of the parks that get repeated use over the course of one season, and these areas and associated bodies of water, particularly freshwater ecosystems could be threatened by human waste contamination. It may be prudent to investigate this issue further.

Second, soundscape disturbance from aircraft (both over flight and access flights) and motorboat use has been raised as an issue in several of the parks, with the

potential existing at all of the parks. Increasingly, the NPS is regarding the natural soundscape as a resource (Jensen and Thompson 2004) and therefore these impacts are included here.

A. Site visits- photo documentation and mapping of representative impacts

Selected examples of the photo documentation and mapping of representative impacts are provided (Figures 1-3). These include examples of sites and trails assessed at LACL and KATM. Compilation of all digital photos, maps and GIS files (including georeferenced images) are provided electronically in support of this report.

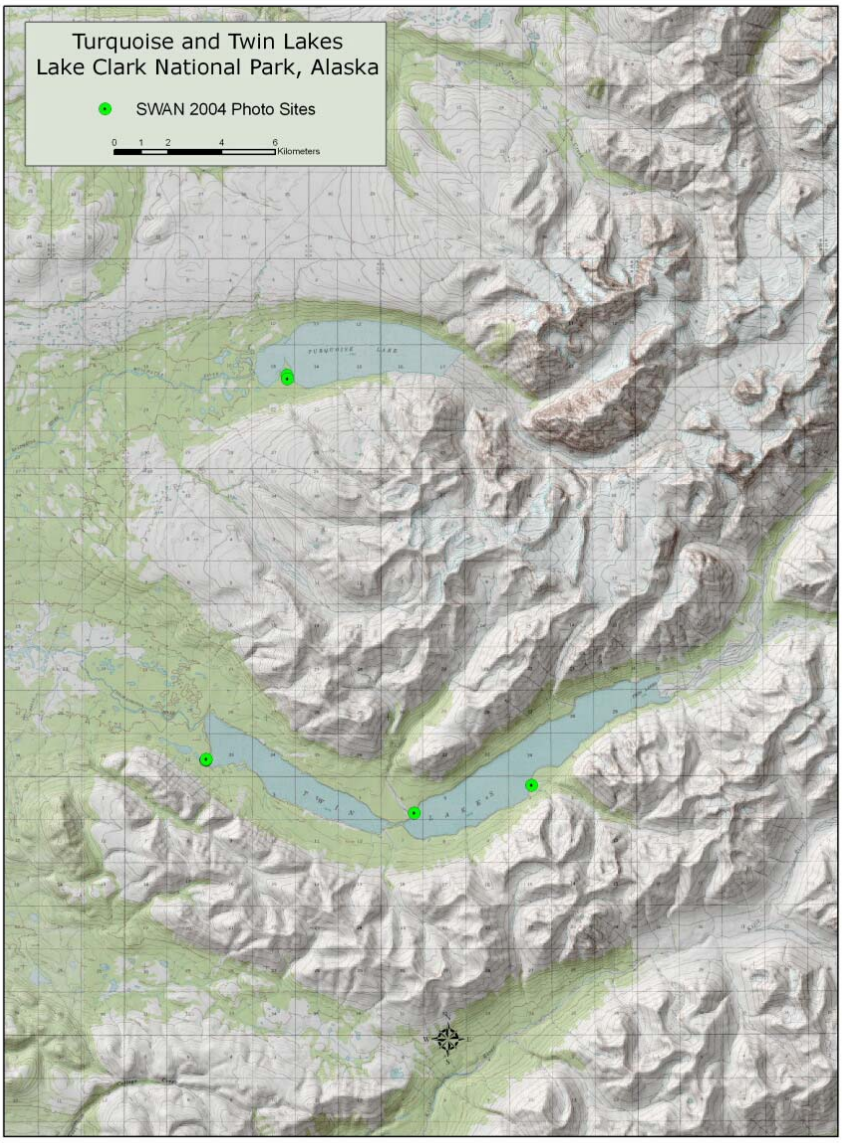

Figure 1. Map of several sites examined at LACL

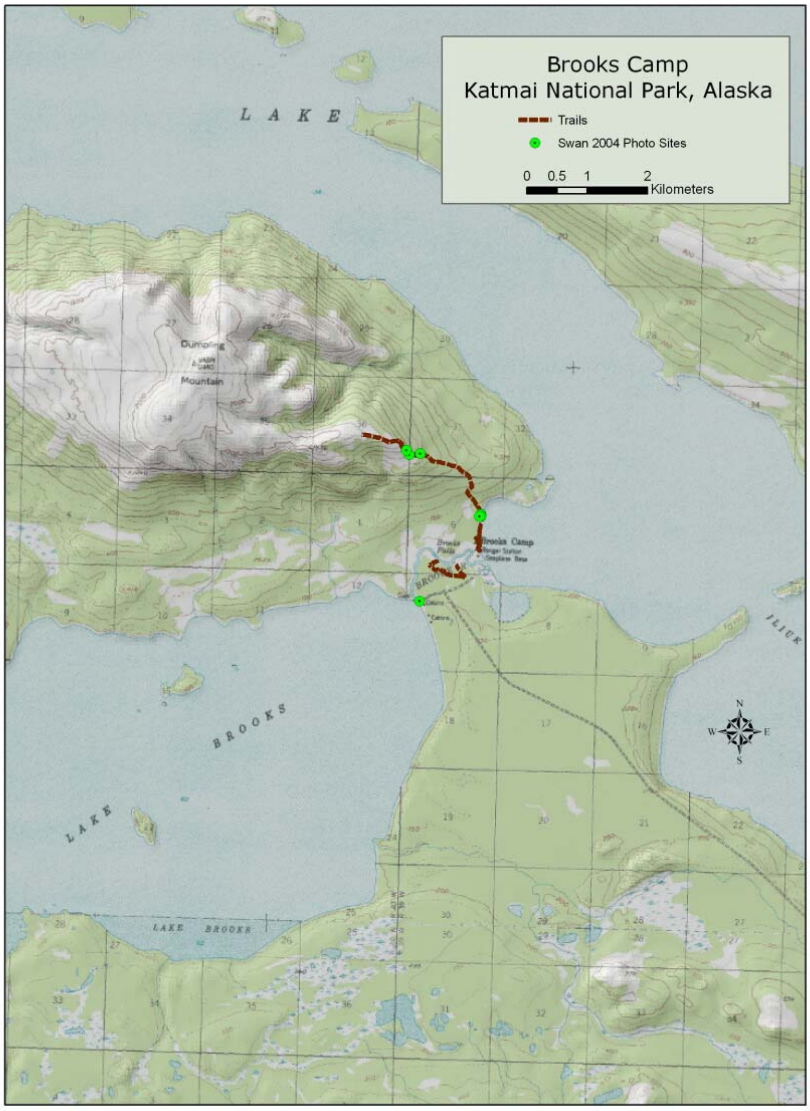

Figure 2. Map of trails and sites at Brooks Camp, KATM

Figure 3. Examples of a visitor created trail and a site at LACL

B. Network wide use and impact commonalities

Soil exposure/loss and vegetation disturbance

Impacts to soils and vegetation due to recreation use were reported by managers and observed during site visits. Impacts observed consisted of the formation of campsites from overnight use, visitor-created trails, stream bank and lake shore disturbance and impacts to established trails such as damage to adjacent areas and trail widening. These impacts although somewhat ecosystem specific in their characteristics, are present or of potential in all SWAN parks.

Aircraft use and associated impacts

Managers consistently raised concerns with the long term consequences of aircraft use in SWAN Parks. While the use of aircraft is appropriate and permissible via the ANILCA legislation (P.L. 96-487), increasing use and associated noise may have a substantial affect on park soundscapes. Associated impacts include the possible displacement of wildlife (Rossman 2004) and increased lake shore disturbance due to loading and unloading floatplanes.

Human disturbance of wildlife

Human disturbance of wildlife, especially bears and shorebirds, is a primary concern at SWAN parks. At present, certain nodes of concentrated visitor use are particularly places where visitors and wildlife interact on a consistent basis. Some interactions are intentional and well managed by the NPS to limit impact, while other interactions are unintentional, of an unknown extent and duration and largely unmanaged. At KATM for example, Brooks Camp is an intensively managed area where visitors come to view bears during the salmon run. Conversely, several areas along the KATM and LACL coast have experienced an increase in visitor activity for bear viewing, but with less management and with the use levels currently undetermined. KEJF coastal backcountry areas contain sites of potential shorebird disturbance when nesting species and campsites are in close proximity.

Dispersed visitor access and use

Managers at all parks expressed concern that current visitor use estimation techniques were underestimating use levels due to the possibility of multiple points of entry. While most visitors seem to follow predictable patterns and popular routes of access by air and water taxi, managers were particularly concerned that increasingly visitors are arriving directly from tourist centers such as Anchorage or Homer via air or water and not passing through places where the NPS has a presence (e.g., Port Alsworth, King Salmon). Moreover, many of these visitors may be traveling to lodges and outfitter camps that exist within the parks, thus forming nodes of visitor use and potential impact. In addition, managers

also stated that aspects of current visitor use estimation procedures, such as the sampling designs, should be examined for statistical accuracy.

C. Suitability of Network Parks for Visitor Impact Monitoring

SWAN parks were evaluated based on several criteria as to their overall suitability for vital signs monitoring (Table 6). Programs of resource monitoring are most applicable to areas where 1) significant park resources could be impaired by visitor activities, 2) creating visitor facilities to reduce impact (e.g., hardened surfaces, boardwalks, developed campsites) is not desirable or practical and 3) the management of visitors is appropriate and desirable. In the following analysis, all parks were found to be suitable for monitoring efforts with the exception of ANIA. Given the remote location and lack of visitation and development, developing visitor impact monitoring is a low priority at ANIA at present.

Table 6. Suitability ranking of NPS areas for visitor impact monitoring

	Suitability Rating by Park1				
Park Selection Criteria	ALAG	ANIA	KATM	KEFJ	LACL
Significant Resource Protection Areas (RPA)	+	+	+	+	+
Visitation common in or near RPA	+	0	+	+	+
Active management of visitor activities	+	0	+	+	+
Facility solutions not practical or desirable in RPA	+	+	+	+	+
Overall importance of monitoring	High	Low	High	High	High

IV-CONCEPTUAL MODEL APPROACH TO INDICATOR SELECTION

The selection of accurate and appropriate vital signs of resource conditions is essential to the development of any program of long-term monitoring. For this project, a two-step process informed the selection of vital sign indicators. First, conceptual models of the interactions of agents of change, stressors and ecosystem responses were developed for visitor use and impacts in SWAN ecosystems and for the soil, vegetation, wildlife, water and soundscape responses within those ecosystems. This conceptual model approach is helpful to illustrate the mechanisms of impact and the ecosystem-level consequences of those impacts and is similar to other approaches of ecological indicator selection adopted by the NPS (Crabtree and Bayfield, 1998; Dale and Beleyer, 2001; Olsen et al., 1992). Second, a matrix of desirable vital sign attributes was developed to aid the decision making process of identifying specific feasible indicators. This section describes the conceptual model approach (Figs. 4-9) while the attribute matrix is described in the following section.

A. Overall Ecosystem Model

For the overall ecosystem model (Fig. 4), three agents of change are identified: visitor/recreation use, resource consumption and land use. Visitors to SWAN parks are engaged in a range of activities (Table 4), each of these of these forms of activities can result in unique impacts. Resource consumption is defined as any activity leading to a direct harvest of flora and fauna including fishing, hunting, and collecting. The land use component includes direct effects as a consequence of visitor activities such as facility development and access development. These three agents result in four major stressors including over-harvesting, invasive species introductions, biotic disturbance, and altered physical environment. The stressors lead to changes within the ecosystem such as changes in the ecosystem structure or changes in the physical or chemical environment.

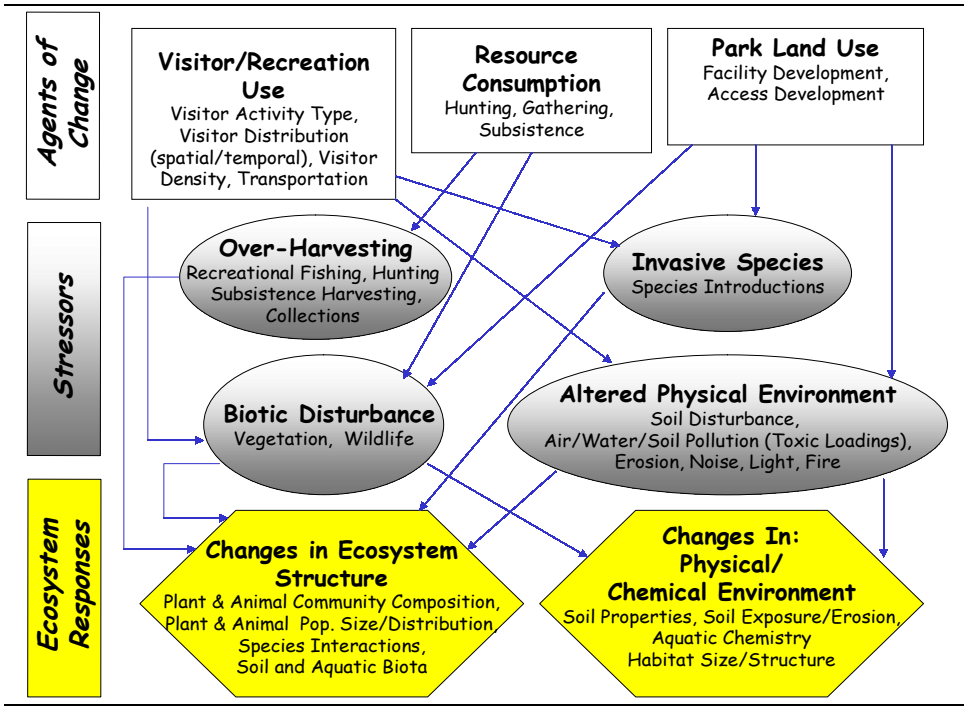

Figure 4. Overall ecosystem model of visitor impacts

B. Vegetation Disturbance

For the vegetation model (Fig. 5), five specific agents are identified, visitor density (the amount of visitors concentrated in one area), visitor distribution (spatial/temporal), visitor activity type (behavior and type of recreation activity), and visitor transportation (by what means they are traveling in the park), and resource consumption (harvest of plant or plant parts).

Trampling, stem breakage, and collecting of plants or plant parts can cause damage to plant structures and may result in displacement of plant species or changes in plant populations. The extent of damage depends on the degree of each agent of change. Through these disturbances, changes in plant populations occur, including direct mortality, reduced vigor, reduced reproduction, and species cover loss. These stressors result in four major ecosystem responses: direct introduction of plant species, species composition change, changes in competitive interactions, and changes in primary production.

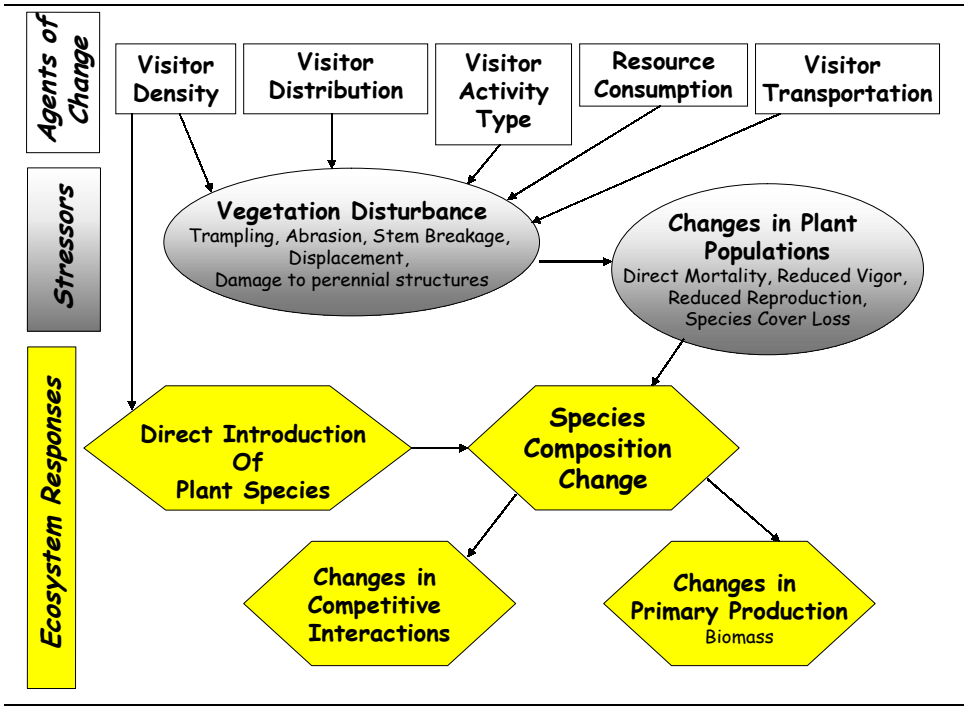

Figure 5. Vegetation disturbance model for SWAN Parks.

C. Soil Disturbance

Four agents of change can lead to soil disturbance: visitor density, visitor distribution, visitor activity type, and visitor transportation (Figure 6). These agents lead to soil disturbance, which occurs through trampling, scuffing, displacement of soil, vehicle tracks, etc. The ecosystem responds to these stressors by soil compaction, soil exposure, and reduction in air, water, and root permeability. The exposure of soil results in erosion, loss of organic matter, loss of soil nutrients, and changes in the soil texture. Changes in soil biota and nutrient cycling occur when there is a reduction in air, water and root permeability and results in erosion, loss of organic matter, loss of soil nutrients, and changes in the soil texture.

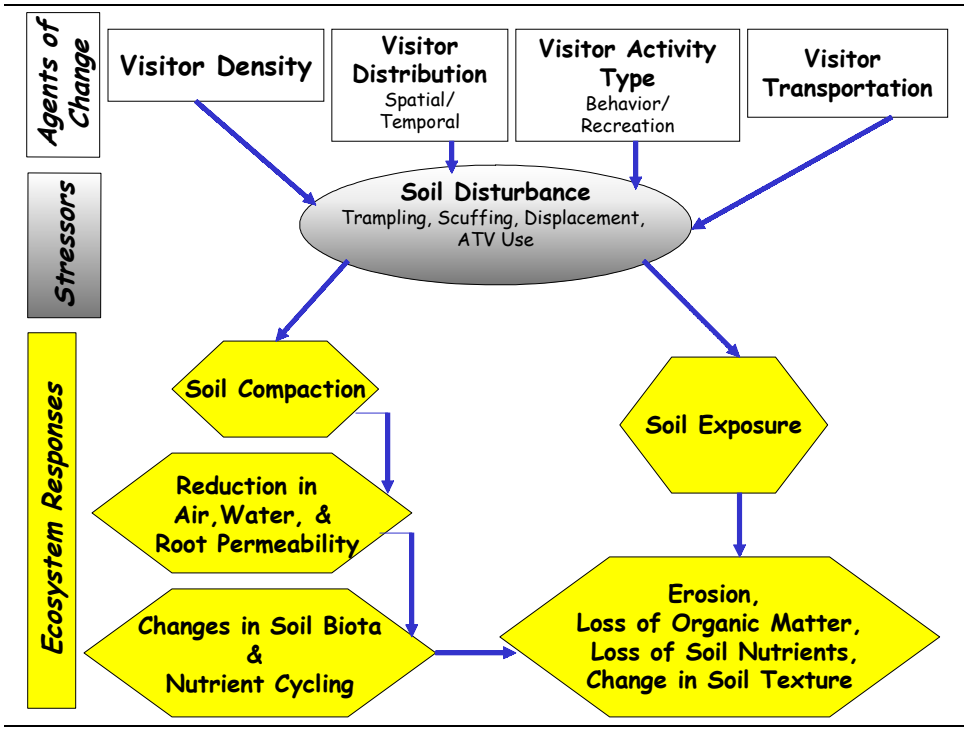

Figure 6. Soil disturbance model for SWAN parks

D. Wildlife Disturbance

As in the vegetation model, five agents of change can lead to wildlife disturbance (Fig. 7). The three resulting stressors direct disturbance, habitat modification, and pollution/trash can cause wildlife to alter their behavior or may alter the energy balance of the affected individuals. The ecosystem consequences of these stressors can be direct mortality of individuals in the affected population, altered productivity of the population (increase or decrease) and species displacement from preferred habitat. Ultimately species composition and population numbers are affected as well as competitive interactions within and among species.

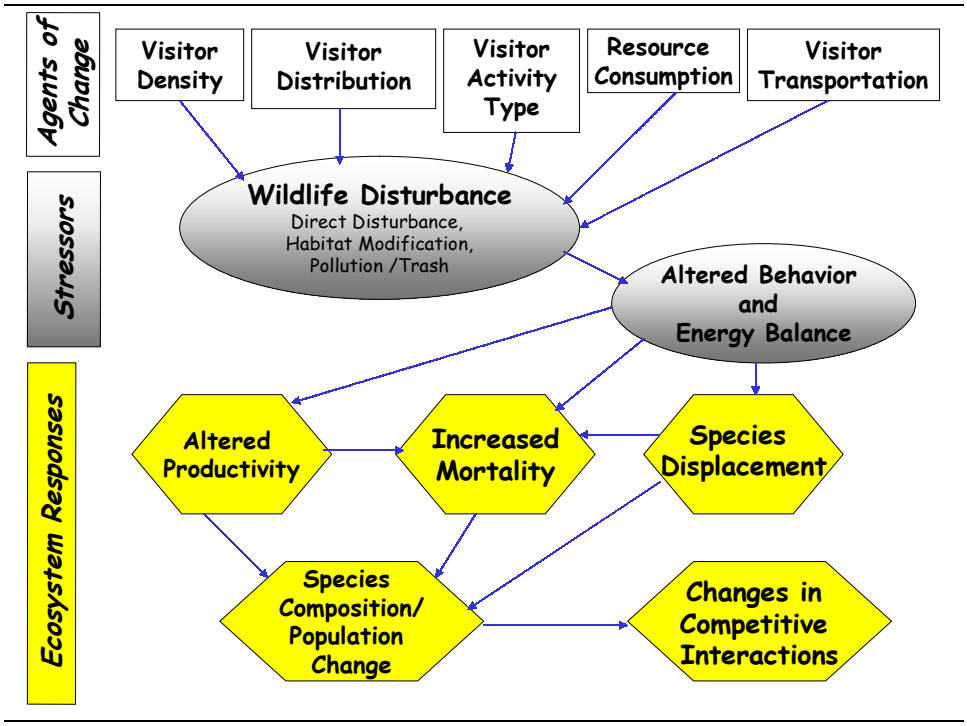

Figure 7. Wildlife disturbance model for SWAN Parks

E. Freshwater System Disturbance

The five agents of change can also play a role when visitor activities are present in and near freshwater environments (Figure 8). The various disturbances to these environments associated with visitor use such as shore and bank disturbance, water pollution, and bacterial contamination can result in an altered physical and chemical environment and/or the direct introduction of undesirable species (e.g., fish stocking or introduction of fecal coliform bacteria). The long term consequences of these impacts are changes in species composition and in competitive interactions in these ecosystems.

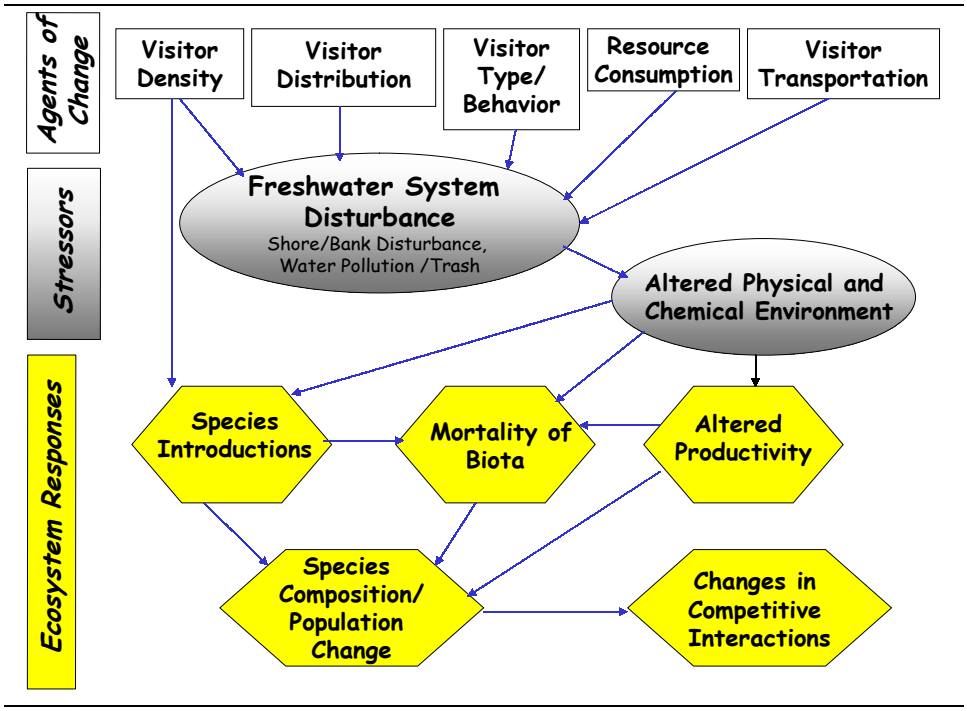

Figure 8. Freshwater system disturbance model for SWAN parks

F. Natural Soundscape Disturbance

Impairment of the natural soundscape from the use of motors in parks has recently been identified as an impairment of park resources (Rossman 2004). In SWAN Parks, noise is primarily associated with aircraft over flights, takeoffs and landings at remote lakes and motorboat use, primarily in the form of outfitter water taxi services (Figure 9). Primary ecosystem level impacts of unnatural and intense noise events include the disturbance, harassment and displacement of wildlife and the resultant ecosystem level consequences. This model also includes disturbance to the visitor experience as natural sounds are an important component of the Alaska park experience.

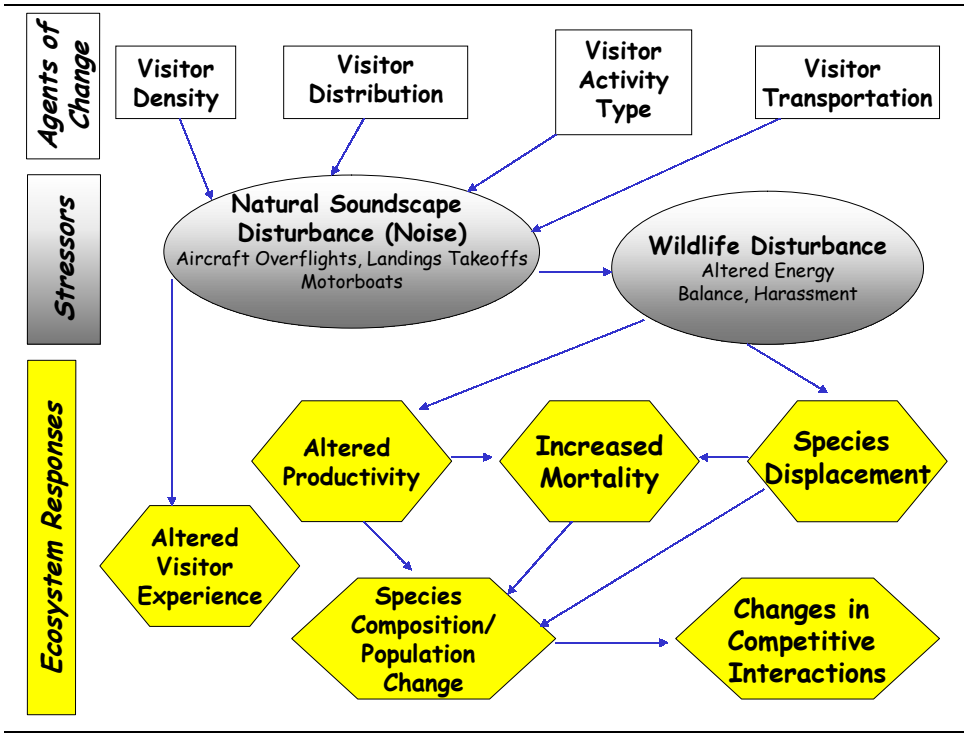

Figure 9. Natural soundscape disturbance model for SWAN Parks.

V-CANDIDATE VITAL SIGNS

Vital signs, sometimes referred to as ecological indicators, are defined as measurable components of the environment that provide logical and demonstrated insights into the condition of the ecosystem under study. The NPS monitors vital signs as a means of sustaining the integrity of park resources since vital signs provide the ability to evaluate efficacy of management actions and warn of impending threats to park ecosystems (Fancy, 2003).

Natural resource impacts associated with visitor use in the form of outdoor recreation, tourism or ecotourism have been identified as one of the major threats to the integrity of ecosystems within SWAN parks (Bennett and others 2003). Accordingly, vital sign indicators of visitor impacts need to be developed as an integral part of the overall Network's vital signs monitoring program. The process of indicator development includes indicator identification, indicator ranking and selection, sampling strategy determination, and field testing and verification. The following describes the first two steps of the indicator development process and concludes with a prioritized list of candidate vital sign indicators.

A. Identifying Candidate Vital Sign Measures

During Phase 1 research of this project a variety of sources were consulted to identify candidate vital signs of visitor impacts applicable to SWAN parks. These sources included scientific literature (e.g., Hammitt and Cole 1998, Monz and Twardock 2004, Section I-C of this report), experiences from recent studies from other Networks of the NPS I & M Program (Monz and Leung 2003), results from interviews with park staff and site visits (Section III this report), and the conceptual models developed for visitor impacts (Section IV this report). The candidate vital sign measures selected are derived from the three major components of visitor impact conceptual models, namely agents of change or pressure, stressors and ecosystem responses, and follow established protocols (Crabtree and Bayfield, 1998; Dale and Beleyer, 2001; Olsen et al., 1992). A summary of the identified candidate vital signs for each of the four major ecosystem components threatened by visitor use (vegetation, soils, wildlife, freshwater and soundscape) is provided along with associated monitoring approaches and vital sign measures (Tables 7 through 11).

Table 7. Candidate vital sign measures of visitor use

Candidate Vital Sign Measure	Monitoring Approach	Unit of Analysis
Visitor Activity Type	Outfitter survey Direct field observation Entry point visitor survey	Dominant activity type; Composition of different activity types
Visitor Density	Outfitter survey Direct observation Automated counters	Scale Ratings of use Frequency Observed number of visitors by activity type Number of hikers along selected trail segments
Distribution of Visitor Use	Outfitter survey Direct observation Automated counters	Location and extent of recreational use

Table 8. Candidate vital sign measures for soil and vegetation disturbance

Candidate Vital Sign Measure	Monitoring Approach	Unit of Analysis
Vegetation Loss/ Soil Exposure	Direct on-site measurement at recreation sites and along trails Digital photo image analysis	Relative cover loss (%) Changes in soil exposure (%)
Vegetation Compositional Change	Direct on-site measurement at recreation sites and along trails	Individual Species Cover (%) Presence/Absence of invasive plant species
Social Trail Formation	Direct on-site assessment and Mapping Digital photo image analysis	Location, extent and mapping of visitor-created trails
Unofficial Site Formation	Direct on-site assessment and Mapping Digital photo image analysis	Location, extent and mapping of visitor-created sites
Shoreline Disturbance	Direct on-site assessment and Mapping in sensitive areas	Location, extent and mapping of shoreline disturbance sites

Table 9. Candidate vital sign measures for wildlife disturbance

Candidate Vital Sign Measure	Approach	Unit of Analysis
Disturbance type	Direct visitor behavior observation	Type of visitor activities affecting wildlife (i.e., shorebirds)
Disturbance time	Direct visitor behavior observation	Length of time of disturbance events
Attraction Behavior	Direct behavior observation	Number of occurrences of wildlife feeding Number of occurrences of attraction behavior
Distribution of Visitor Use	Outfitter survey Direct observation Automated counters	Location and extent of recreational use in proximity to wildlife habitat

Table 10. Candidate vital sign measures for freshwater system disturbance

Candidate Vital Sign Measure	Approach	Unit of Analysis
Fecal Coliform Bacteria	Sampling and laboratory assessment	Presence/Absence Counts
Turbidity	Field assessment	Quantity of suspended solids

Table 11. Candidate vital sign measures for soundscape disturbance

Candidate Vital Sign Measure	Approach	Unit of Analysis
Aircraft/ Motorboat Noise	In field recording	Presence/Absence Number of incidents Duration
Aircraft Landings and Takeoffs	Field observation In field recording	Number, frequency and type

B. Criteria for Ranking Vital Signs

Not all of the above (Tables 7 through 11) candidate vital signs can or should be implemented in the SWAN vital sign monitoring program. With all monitoring efforts, practical considerations, such as the monetary cost, staff time, protocol complexity and importance to park management should play a role in determining a feasible approach. A process for ranking and selecting candidate vital sign indicators for protocol development is therefore an essential next step.

Several recent studies have suggested approaches for the selection of general ecological indicators (Consulting and Audit Canada, 1995; Jackson et al., 2000) and visitor impact indicators. (Belnap 1998; GYWVU 1999, Manning, Leung and Budruk, 2003). In addition, these approaches have been reviewed and modified for application to visitor impact monitoring for the NPS vital signs program (Monz and Leung 2003). For this study, an approach similar to Monz and Leung (2003) was employed, with appropriate modifications. Fourteen selection criteria (Table 12) were used to evaluate the candidate vital signs with the first four being required criteria that must be fulfilled by any candidate indicator to be

considered for selection. The remaining ten are optional criteria that are used for evaluating the desirability of candidate indicators that have met the required criteria.

Table 12. Evaluation criteria for candidate vital sign measures[1].

CRITERIA	DESCRIPTION
Low measurement impacts	The indicator can be measured with no or minimal level of ground disturbance
Reliable/Repeatable	The measurements of indicator by different field staff would show reasonable agreement
Correlation with use	The indicator is directly related to visitor use with good level of correlation
Ecologically relevant	The indicator must have conceptual relevance to concerns about ecological condition, i.e., it must be a component of the appropriate conceptual model. It must reflect an important change of resource condition that would lead to significant ecological or social consequences
Respond to impacts	Change of resource condition can occur promptly after impacts are introduced
Respond to management	Resource conditions can be manipulated by management actions
Feasible to measure	Field measurements are relatively straightforward to perform with minimal level of equipment needed
Low natural variability	Indicator has a limited level of spatial and temporal variability
Large sampling window	Field measurements can take place in most seasons
Cost effective	Measurements of indicator are inexpensive. Little additional cost to management. Data gathered benefit management
Easy to train for monitoring	Field staff with no prior knowledge of field procedures can be easily trained to perform such procedures
Baseline data	There are existing data on the indicator, preferably with the nature of the use-impact link established
Measures multiple indicators	Possible to measure another indicator directly by assessment of primary indicator
Response over different conditions	Impacts can be measured while still relatively slight

[1] The first four criteria are required while the remaining ten are desirable criteria. These criteria were adapted from Monz and Leung (2003) and are based on Belnap (1998), Consulting and Audit Canada (1995), GYWVU (1999) and Manning et al. (2003).

C. Ranking Results: Prioritized List of Candidate Vital Signs

All sixteen candidate vital signs identified in Section A were evaluated based on the fourteen criteria described in preceding section. A summary of the evaluation process in form of a two-dimensional matrix is provided (Table 13). Numerical totals for each vital sign at the base of each column are calculated by counting the "+" and "-" symbols as +1 and -1 respectively with the "0" and the "?" equaling zero. The result of this process is presented as a list of candidate vital signs in a low, medium and high priority for adoption by the network and for further protocol development (Table 14). High priority indicators are those recommended for adoption in the Network's vital signs monitoring program, while the low medium priority indicators require further discussion by the Network as to whether these should be examined further. Note that in all likelihood a subset of the recommended vital signs measures will be selected for protocol development based on park and network priorities. This comprehensive, ranked list is provided to initiate this process. After final selection of a vital sign measure, specific protocol alternatives will be evaluated and compared based on their cost effectiveness and performance in Phase 2 of this project.

Table 13. Evaluation matrix of candidate vital sign measures for visitor impacts.

SELECTION CRITERIA*	CANDIDATE VITAL SIGN INDICATORS										
	Visitor Activity Type	Visitor Density	Dist. of Visitor Use	Veg Loss/ Soil Exp.	Veg Compo-sition Change	Social Trail	Un-official Sites	Shore Disturb.	Wildlife Disturb. Type	Wildlife Disturb. Time	Attraction Behavior
Low measurement impacts	+	+	+	+	+	+	+	+	+	+	+
Reliable/Repeatable	0	0	0	0	0	0	+	0	0	0	0
Correlation with use	+	+	+	+	+	+	+	?	+	+	+
Ecologically or socially relevant	+	+	+	+	+	+	+	+	+	+	+
Respond to impacts	+	+	+	+	+	+	+	+	+	+	+
Respond to management	+	+	+	+	+	+	+	+	+	+	+
Easy to measure	+	+	0	+	?	+	+	+	0	0	0
Low natural variability	+	+	+	+	+	+	+	0	?	?	?
Large sampling window	+	+	+	+	+	+	+	+	-	-	-
Cost effective	0	0	0	0	0	0	0	0	-	-	-
Easy to train for monitoring	+	+	+	+	+	0	+	0	0	0	0
Baseline data	0	0	0	+	-	+	+	+	0	0	0
Measures multiple indicators	-	-	+	-	-	+	+	+	-	-	-
Response over different conditions	+	+	+	+	?	+	+	?	?	?	?
Priority	M (9)	M (9)	H (10)	H (10)	M (6)	H (11)	H (13)	M (8)	L (2)	L (2)	L (2)

* The first 4 criteria are required while the other 9 are desirable criteria.
+ = Criterion satisfied 0 = criterion partially satisfied (or varies by zone/area) - = criterion not satisfied ? = questionable/undecided
n.a. = not applicable

Table 13 continued. Evaluation matrix of candidate vital sign Measures for visitor impacts.

SELECTION CRITERIA*	CANDIDATE VITAL SIGN INDICATORS			
	Fecal Coliform	Turbidity	Aircraft Noise	Aircraft Landings /Takeoffs
Low measurement impacts	+	+	+	+
Reliable/Repeatable	0	0	+	+
Correlation with use	0	0	+	+
Ecologically or socially relevant	+	+	+	+
Respond to impacts	0	0	+	+
Respond to management	0	0	+	+
Easy to measure	-	+	+	+
Low natural variability	-	-	+	+
Large sampling window	+	+	+	+
Cost effective	0	+	-	0
Easy to train for monitoring	+	+	+	+
Baseline data	0	0	0	+
Measures multiple indicators	-	-	+	+
Response over different conditions	+	+	+	+
Priority	L (2)	M (5)	H (11)	H (13)

Table 14. A prioritized list of candidate vital sign measures.

Priority for Protocol Development	Candidate Vital Sign Measures
High	Distribution of Visitor Use
	Vegetation Loss/ Soil Exposure
	Social Trail Formation
	Unofficial Site Formation
	Aircraft Noise
	Aircraft landings/takeoffs
Medium	Visitor Activity Type
	Visitor Density
	Vegetation Composition Change
	Shoreline Disturbance
	Turbidity
Low	Wildlife Disturbance Type
	Wildlife Disturbance Time
	Attraction Behavior
	Fecal Coliform

VI-SAMPLING CONSIDERATIONS FOR SWAN PARKS

With any element of resource monitoring careful consideration should be given to the statistical accuracy and representative nature of the sampling design. Specific and extensive guidelines for the assessment of park biological resources have been suggested in the context of the NPS Inventory and Monitoring program (Fancy 2000; Geissler and McDonald 2003). These guidelines provide a basis for the determination of the sampling design of this study. The nature of visitor impact requires additional considerations that in some cases may supercede standard biological sampling protocols, especially when factors such as efficiency and cost effectiveness are examined.

A. Spatial Scale Considerations

As mentioned previously in this report, Alaska National Parks represent some of the last true wilderness areas in the world. In the context of these values, SWAN Parks are prime examples, with a general management direction of a minimum of facilities, dispersed visitor use over wide geographic area, and in general a relatively low frequency of visitor impact occurrences across the landscape. Although visitor activity impacts may occur in many park areas, impacts occurring within sensitive, natural or resource protection zones are of most concern because of their ecological and social value. In more developed parks (such as many of those in the lower 48) distinctions must often be made between areas where facility solutions will be employed to minimize visitor impact (e.g., frontcountry areas) and backcountry areas where more unobtrusive and indirect

management of visitors to allow naturalness to dominate the landscape is desired. With a few important exceptions, SWAN parks have little frontcountry and therefore monitoring is of primary importance as visitor impacts can pose a substantial threat to ecological integrity.

Visitor impacts often exhibit predictable patterns spatially as visitors often consistently use the same or adjacent places on the landscape (Hammitt and Cole 1998). As such, recreation impacts tend to be highly concentrated with use and impacts restricted to travel routes (trails) and destinations (sites). This phenomenon has been described a node and linkage patterns, with nodes of impact forming at destination areas and linkage impacts forming along routes, between nodes (Manning 1979). Given these patterns and that it is generally possible to locate visitor impacts (i.e., soil and vegetation) and potential impacts (i.e., wildlife interactions), large scale, grid based sampling designs are typically not utilized in visitor impact monitoring. As in many visitor impact studies, future protocol development will likely rely on the predictable node-linkage pattern combined with information on visitor use and distribution to locate and determine the extent of resource impacts.

B. Permanent Plot Re-Measurement

Permanent plot designation and subsequent re-assessment is desirable for NPS vital signs monitoring (Fancy 2000) and lends well to visitor impact monitoring. Typically visitor sites and trails are mapped and assessed in such as way as to allow for the relocation of assessment points over time as the changes in existing trails and sites are a straight-forward indicator of overall impact trends. Most of the SWAN parks have previous data on the location of visitor impacts (sites and trails) and future protocol development will utilize this information to a full extent.

C. Sampling Within Visitor Nodes and Linkages

Sampling strategies for the determination of impacts within visitor nodes (sites) and linkages (trails) are well developed and have been extensively reviewed (e.g., Hammitt and Cole 1998; Monz 2000; and others) and applied (e.g., Marion and Cahill 2003). For this study, we will follow these well established protocols. Typically for trails, impact *measurements* (trail width, depth, etc.) are performed at regular intervals systematically along individual trail segments while other *estimates* of integrated variables, such as condition class ratings, are performed more continuously as the trail assessment proceeds. This combined approach has the advantage of providing information that is able to characterize entire trails segments and also plot-specific so that areas can be re-measured for future trends. For SWAN parks, there is relatively little data on trail conditions and associated impacts (with the exception of Exit Glacier, KEFJ), so protocol future development will emphasize trail procedures for the relatively few established trails and areas of potential trail formation.

Visitor sites are often measured using assessment procedures that integrate impact measurements across the entire site. This approach is effective in areas where sites are relatively small (i.e., 5-10 m in diameter) and specific impact variables, such as vegetation cover loss, can be determined adequately for the entire site by visual estimates. In larger areas, and for some measurements (e.g., soil compaction), random or grid-based subsampling schemes are desirable and can be utilized.

D. Sampling for Visitor Use Estimation

The determination of visitor use and distribution is a complex and challenging task in SWAN parks for several reasons. First the parks are large and complex geographically, making it difficult for park staff to be present frequently in all areas of visitor use. Second, staff are limited and some techniques for use estimation are labor intensive. Last, and perhaps most important, although many visitors travel in predictable patterns through major access points, not all do. In addition some areas have recently seen increased use (such as the KATM and LACL coasts) that may be difficult to assess accurately.

Nonetheless, many opportunities exist to improve estimation techniques at most of the SWAN parks, particularly by adopting statistical sampling strategies. Visitor use estimation techniques and sampling strategies for wilderness settings have been reviewed and compiled (Watson et al., 2000). This work clearly demonstrates the importance of statistical sampling designs in terms of increasing accuracy, reducing staff time and elimination of observer bias. In addition, multiple measuring techniques, where appropriate, such as the use of outfitter surveys and mechanical counters will be a consideration given the complexities of these measures in the Parks.

VII-CONCLUSIONS AND PHASE 2 DIRECTIONS

Impact and use concerns and monitoring needs

- With the exception of ANIA, SWAN Parks have areas where existing visitor use has resulted in resource impact. These existing impacts can be generally categorized as areas of vegetation and soil loss, human disturbance of wildlife and aircraft activities and associated impacts. In general, managers have expressed these concerns and these impacts can be observed readily in the field. The proposed list of prioritized Vital Signs (Table 14) suggests options for future protocol development in each of these general impact categories. It is suggested that Vital Signs given a high priority ranking be considered by the SWAN for protocol development while medium and low priority vital signs be examined further.

- Visitor use estimation—particularly in backcountry areas of all SWAN Parks—is a concern of park managers. The large geographic area of the parks combined with the possibility of numerous routes and means of entry complicate the compilation of these data. Given the importance of visitor use distribution, future protocol development should include this vital sign. It is likely that in some parks unique methodologies will need to be developed that employ multiple means of enumerating visitation.

- Despite visitor impacts to wildlife being a primary concern at nearly all of the SWAN parks, several of the wildlife disturbance vitals signs ranked low in the evaluation process. This was due primarily to the difficulties and cost of measuring these indicators in the field and of the concern that these measures were not direct assessments of wildlife impact. Full scale research studies of human disturbance to wildlife (e.g., Smith 2002) are not usually possible in the context of park monitoring efforts. One possible approach to be evaluated is to measure visitor use and distribution and to map visitor sites along with parallel efforts assessing wildlife populations and distribution (Tom Smith, personal communication). In the case of SWAN Parks, this approach may be appropriate for both shorebird nesting sites and bear habitat.

Status of Existing Data and Existing Protocols

- Several of the SWAN parks have established protocols for assessing some aspects of visitor use and impacts, particularly those impacts associated with camping (Tables 1 and 2). Currently, however, it appears as if more data have been collected than have been compiled and analyzed. Also, it is possible that existing field methodologies can be streamlined as part of this Vital Signs Program allowing for a more effective and efficient collection and analysis process. Phase 2 of this project will examine the

existing field protocols and suggest options for modification. The status of current data will also be examined.

Methodological Development

- For the majority of the vital signs selected (Table 14) well developed assessment procedures exist. Therefore, the majority of the protocol development in the next phase of this project should focus on adapting these existing protocols to the specific situations in SWAN Parks.

- Although more examination is needed, it appears that campsite protocols (e.g., Table 1) are well developed and of sufficient detail to provide accurate information. It is possible, however that these protocols are more complex and difficult to complete in the field than required for Vital Signs monitoring. For example, it is possible that digital photography combined with image analysis may replace many of the field estimates that require significant staff time. The development of this methodology will be addressed in Phase 2.

ACKNOWLEDGEMENTS

The author thanks Prof. Paul Twardock for his help in coordinating all the field components of Phase 1 of this project and for his expertise in the KEFJ component of the site visits. Stuart Gardner provided considerable field help and expertise in the KATM and ALAG site visits. Bill Olsen provided countless hours of GIS and GPS support and guidance.

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APPENDIX 1- SCOPING WORKSHOP SUMMARY

SWAN Visitor Impact Scoping Workshop Summary
May 6-7, 2004, Anchorage, AK

I. Introduction

A preliminary scoping workshop on the extent of manager's concerns regarding visitor impacts at the Southwest Alaska Network (SWAN) parks was held on May 6th and 7th, 2004 at the National Park Service (NPS) regional office in Anchorage. This workshop was the initiation of the Phase 1 work of the SWAN Visitor Use and Associated Impacts study. As such, this meeting served as the beginning of the general scoping of the extent and location of visitor impact concerns as reported by managers of the SWAN parks. In order to fulfill the overall goals of the monitoring project as proposed, the meeting had the following specific objectives:

- Project staff gained general information from park managers on the purpose and unique aspects of the SWAN parks
- Park managers were informed more specifically to the project goals in an effort to gather additional feedback
- Major visitor issues and impacts were discussed including the following:
    - Initial discussions as to significant park ecosystems/environments where visitor activities are occurring
    - Types of visitor activities
    - The general location and extent of visitor impacts
    - Initial discussions as to priority ranking of important visitor impacts
    - Visitor impact commonalities across SWAN parks
- Previous visitor impact monitoring projects, if any, were identified. Availability of data was discussed including currently available GIS data.
- Coordination for site visits for June and July 2004 was initiated.

This report serves as a summary of the preliminary findings regarding impact concerns as discussed at the workshop. Specifically, this report focuses on the third goal (above) and presents summary points of the types, location and extent of reported impact concerns for each park and an analysis of impact commonalities across all SWAN parks. Over the course of Phase 1 of this project (2004), site visits, discussions with park staff, and feedback on draft reports will serve to continue to inform the project staff regarding these issues. Many of the above goals were not completed in sufficient analysis detail at the scoping meeting and required further work. As such, these conclusions on the scoping process and identification of additional information needs will be included in the project Phase 1 Report to be completed in November 2004.

Those present at the meeting included project staff Chris Monz and Peter D'Luhosch and NPS staff Dorothy Mortenson SWAN, Eveline Leon Martin KEFJ, Judy Putera LACL, Bill Thompson SWAN, Troy Hamon (phone KATM) Ian Martin (phone KEFJ). Sarah Wesser and Janis Kozlowski were also consulted.

II. Visitor Use and Impact Concerns by Park

Katmai National Park and Preserve

Troy Hamon described some of the various visitor use characteristics and potential impact issues in KATM, ALAG and ANIA. In the context of this discussion, a distinction was made between "front country" or areas of more developed, facility oriented recreation opportunities and "backcountry" or areas of primitive camping generally in a more dispersed use pattern. In general in SWAN parks there are very limited front country visitor opportunities, but there are some important ones—such as the Exit Glacier area in KEFJ and the Brooks Camp area in KATM. This distinction will be used in individual parks where appropriate.

Brooks Camp is an area of concentrated visitor use in KATM with facilities provided (lodges, viewing platforms, designated camping areas, etc.).

Visitor Impact Issues

- Some depreciative behavior in camp: disturbing bears and providing food rewards
- Trash issues
- Portage, hiking and social trails

Visitor Use Characteristics and Access

- Access by float plane from King Salmon and private lodges outside of park.
- Photo and fishing tours and charters
- Aircraft from King Salmon, cruise ships from Kodiak and Homer to Kukak Bay, Hallo Bay, Geographic Harbor. Visitors come ashore on Zodiacs to observe bears and go fishing
- Kayak rentals are available in Brooks Camp
- Road use to the Three Forks Overlook and Naknek River

Issues in backcountry areas of KATM include:

Visitor Use Characteristics and Access

- Lodges: at least one on the coast, five in the interior of park
- Shore camping exists but is rare

- The Preserve is host to fishing, hunting, and bear viewing, all via float plane.
- There is day use and some camping at "established" campsites.
- American Creek, the Kulak River, and Murray Lake all host boating, rafting and fishing use

Alagnak Wild River

Troy Hamon also led our discussion of ALAG.

Visitor Impact Issues

- Visitor created campsites exist along the river
- Documented cultural resources (archeological site) mandate no digging practices. Consequently there is a potential for human waste impacts due to surface disposal.
- Wildlife disturbance concerns (unspecified)
- Shore and bank disturbance possible due to fishing access.
- In some cases, visitors appear to be following existing wildlife trails along the river resulting in a widening of these trails
- Private property allotments on the river occupy the majority of "desirable" campsites. This leads to high use of the remaining suitable camping locations
- Subsistence use in area consists of caribou hunting, bird hunting, and fishing. There is some concern as to the "illegal" use of ATV's associated with subsistence use

Aniakchak

Visitor Use Characteristics and Access

- Uses include: hunting, fishing, rafting, hiking, and subsistence hunting and fishing
- Estimated visitor use is approximately 300 visitor days per year
- There are reports of commercial operators accessing the area but use level and frequency is currently not known.
- There are three hunting guides. Each service 10-15 clients during a 10 day bear season
- Some float plane fishing in the lower river exists.
- The area receives a very few hiking and rafting visitors—perhaps on the order of one or two parties per year. These are flown in from lodges, are through hikers, rafters planning to float the river from the Caldera to the Sea. There is the potential for this activity to increase in the future
- "Illegal" ATV use suspected

Lake Clark National Park and Preserve

Judy Putera led the discussion of LACL. Port Alsworth on Lake Clark is the site of most internal staging. There is a visitor center (no public facilities) and approximately five lodges. Visitors use float planes from Port Alsworth, Anchorage, Homer and Soldotna to access the interior and coastal regions of the park. The Park has also been observing increased boat traffic to the LACL coast from Homer and Kenai.

Visitor Impact Issues- Interior

- Many of the lakes have potential impacts associated with the staging operations of float planes (loading and unloading). Mainly this is disturbance to shore vegetation and soils.
- Human waste issues have inspired talk regarding toilet facilities

Visitor Use Characteristics and Access- Interior

- Twin, Turquoise, and Telaquana Lakes. Hiking between lakes is popular
- Twin and Telaquana lakes have Ranger cabins
- Chilikadrotna River (Twin Lake) is a popular rafting area
- Snipe Lake is a popular destination for caribou viewing
- Kijik Lake and its trail are popular with fishermen
- Popular hiking trail from Port Alsworth to Kontrashibuna Lake.
- Private lodges on Lake Clark, Port Alsworth and elsewhere in the park and preserve such as Upper Twin Lake and Fishtrap Lake.

Visitor Impact Issues- Coastal

- Wildlife disturbance, primarily disturbance to bears from viewing activities including use of zodiacs to land visitors and aerial viewing of bears from planes
- Some concerns about trampling of vegetation and soil disturbances

Visitor Use Characteristics and Access- Coastal

- Bear viewing in Chinitna Bay, a salt marsh meadow with mud flats (Ranger facility)
    - Private lands adjacent to Bay
    - Aircraft disturbances to wildlife
- Silver Salmon Coastal Area Private lodges with ATV use
    - Bear viewing and fishing
    - Bear / human interactions due to bears being attracted to area because of fishing activities
    - Silver Salmon Lakes might see some visitor access form adjacent native lands
- Tuxedni Bay
    - Salt Marsh / Bear habitat

    - Boats from Homer and Kenai deploy zodiacs (Sea Bear Charters) this promotes potential wildlife disturbances and disruptions
    - Aerial bear viewing
- Crescent Lake
    - Lodge activities

Kenai Fjords National Park

Evelyn and Ian Martin lead the discussion regarding KEFJ.
Summer use: Road to Exit Glacier and Creek with a parking lot and camp grounds

Visitor Impact Issues- Exit Glacier and Environs

- Exit Glacier and Creek, and the outwash plain see heavy visitation primarily via a system of developed trails, prompting concerns of impacts to the area of primary succession near the toe of the Exit Glacier
- Some human waste and trash impacts
- Social trails impacting emerging vegetation
- Black bear encounters (bears use same areas as human visitors)
- Concentrated use concerns
- Visitor introduced invasive plant species (dandelion)
- Rare plant trampling
- Other wildlife impacted:
    - Mountain goats

Winter use and impacts:

- Low non-motorized use
- Snow machine visits to Exit Glacier, Paradise Valley, Exit Creek
- Concerns over displacement of moose and of vegetation (browse) damage due to snow mobile use.

Visitor Impact and Use Issues- Coastal (Primarily discussion centered on Aialik Bay and environs)

- Tour and charter boat provide visitation access both overnight and day tours
- Kayakers are primary overnight users both in developed cabins and in campsites
- Camping beaches are limited by geography and see frequent use
- Two public use cabins in Aialik and one in North Arm
- Some fly in visitation of campers and fishermen from Homer
- Human waste and trash must be collected and flown out (river boxes)
- Potential impacts to shore nesting birds (Black Oystercatcher and Spotted Sandpiper) and harbor seals

III. Primary Visitor Impacts to SWAN Park Resources

- Visitor disturbances of wildlife primarily as a consequence of wildlife viewing and photography. This sometimes involves the use of boats and aircraft to arrive in the proximity of wildlife
    - Bear, brown and black
    - Moose & caribou (Kenai and Lake Clark)
    - Oystercatcher and other shorebirds
- Soil and Vegetation disturbances as a consequence of visitor use off designated trails and sites
    - Visitor-created trails
    - ATV's
    - Float plane and boat landings (gear loading areas)
    - Visitor created campsites
    - Stream bank disturbance from fishing
    - Trampling impacts to vegetation in areas of primary succession
- Impacts from aircraft use, both overflights (flightseeing) and landings and take offs (backcountry access)
    - Noise
    - Aesthetics
    - Wildlife disturbance (as mentioned above)
- Snowmobile impacts
    - Moose disturbance
- Subsistence use?

IV. Impact Commonalities in SWAN Parks

- Human disturbance of wildlife
    - Bear, brown and black
- Soil and Vegetation
- Campsites
- Visitor created trails
- Shore disturbance (lakes, ocean, bay, river)
- Aircraft overflights

V. Conclusions

In addition to the above summary points by park, overall impact concerns and impact commonalities, a few general conclusions can be made based on our discussions. First, wilderness/backcountry use estimation is a major concern of managers. In general, some information is available at each park in these regards, but managers are concerned about the reliability and accuracy of the data. Second, some information has been gathered by the parks on impacts such as human-wildlife disturbances (bear) and on campsite location and extent of impact. Last, significant challenges exist in implementing monitoring strategies at these parks including personnel limitations, logistic considerations and

financial constraints. It is the goal of this project to offer monitoring alternatives so that the above limitations can be overcome to the greatest extent possible.

APPENDIX 2- SUMMARIES OF PARK VISITS

Site Report
Katmai National Park
SWAN Project 2004

Introduction: Located in Southwest Alaska, Katmai was declared a National Monument in 1918. Initially the primary park purpose was to preserve the geologic remnants of the eruption of 1912, but more recently, protection of brown bear habitat has become an important aspect. In 1980 the area was designated a National Park and Preserve. Katmai is a vast park, much of which is not seen by visitors. Common visitor experiences consist of fishing from Brooks Camp, walking up to Brooks Falls, and riding the bus out to the Valley of Ten Thousand Smokes.

Staff Present: The NPS was represented by Troy Hamon and the NPS staff at Brooks Camp. The Project was represented by Peter D'Luhosch of St. Lawrence University and Stuart Gardner.

Impact and Use Concerns: The site visit had two main components; a period spent working in and around Brooks Camp, and a two day study of impacts in the Valley of 10,000 Smokes. Brooks Camp and its immediate surroundings showed impacts typical to concentrated use zones. The trails in camp and those providing access to the bear viewing platforms all showed signs of widening, and encroachment onto undisturbed vegetation. Access points to fishing locations also showed signs of increasing impact. Human interactions with wildlife seemed continual, as visitors moved in the presence of bears. A trail up Dumpling Mountain contained locations of off trail visitor created disturbance. Visitor impacts in the Valley of 10,000 Smokes were concentrated around the Three Forks Cabin and, further into the Valley, near sources of shelter and drinking water. The areas around the Ukak Falls, Confluence, and Six Mile Campsite, were the locations of the highest level of impact. The impacts observed included those associated with visitor created trails, trail widening, and soil erosion. There was also damage to emerging and existent vegetation. Campsite use issues ranged from the presence of tent rocks and other means of fortifying temporary shelters to the actual construction of unofficial tent sites. These areas showed signs of leveling and the use of stone reinforcements.

Conclusions: Brooks Camp is akin to a frontcountry location and its impacts can be viewed as such when prioritizing park zones to be monitored. The Dumpling Mountain trail could be monitored for visitor disturbance to soil and vegetation. The less traveled Valley of 10,000 Smokes provides opportunities for the monitoring of fresh water near campsites. As such, testing protocols for water quality, vegetative loss, and campsite based disturbances to the landscape could all be tested in one or a few centralized locations. Use estimation, while fairly simple in the frontcountry zones, might prove more difficult in the highly

dispersed backcountry areas. Camp concessionaires and private outfitters might provide assistance with visitor use data. Both the camp and valley locations receive soundscape disturbances and could be monitored for such disturbances.

Site Report
Kenai Fjords National Park
SWAN Project 2004

Introduction: Kenai Fjords National Park encompasses over 600,000 acres on the southeast coast of Alaska's Kenai Peninsula. The park is capped by the Harding Ice Field, the largest ice field entirely within U.S. borders. Orcas, otters, puffins, bear, moose and mountain goats are just a few of the numerous animals found in this ever changing place of mountains, ice, and ocean.

Staff Present: The NPS was represented by Ian and Eveline Martin, from the Seward office, and Rangers Jannette Chiron and Greg George, stationed in Aialik Bay. Project staff were Chris Monz and Peter D'Luhosch, both from St. Lawrence University, and Paul Twardock of Alaska Pacific University.

Impact and Use Concerns: An initial meeting between KEFJ staff and project representatives was held on 6/16/04. At this meeting, project goals were reviewed and manager's visitor use concerns discussed. The increased visitor impacts associated with snow machine use were identified as a primary concern for KEFJ's immediate future. Other issues discussed were related to visitor based stressors to wildlife, flora, and the soundscape.

A site visit to the Exit Glacier illustrated examples of vegetation and soil loss. The area is primarily a day use location and thus, camping impacts were restricted to designated sites. The area around the toe of the glacier receives considerable foot traffic and concentrated use. General trail erosion on the Harding Icefield Trail is also a concern. Visits were made to the Holgate Glacier, Quicksand Beach, McMullen Bay, Pedersen Lagoon, and the areas around Aialik Bay public use and Rangers cabin facilities. A variety of trails, camping, and day use sites were observed. Impacts associated with camping, kayak and boating activities, and some day use were found. Tent sites, unintentional trails, and disturbances to vegetation were present. Campfire impacts were present. The regular presence of tour boats and float planes suggested that impacts to the soundscape and visual aesthetic were also of possible concern.

Conclusions: By virtue of its location and ease of access relative to other SWAN parks, KEFJ is the logical location for the testing of visitor estimation protocols. The Exit Glacier site serves as a front country model of visitor use, while Aialik bay would be more suitable for backcountry based testing concerns. As such, trail counters might prove valuable in settings such as Exit Glacier and around the backcountry public use cabins, but less helpful in the more remote areas of the Park where use is highly dispersed. Visitor use estimation in backcountry sections of the Park will provide more of a challenge and remains an issue for further research. Backcountry sites will provide ample opportunity for the development and testing of impact protocols applicable to coastal campsites.

Site Report
Lake Clark National Park
SWAN Project 2004

Introduction: Lake Clark National Park and Preserve contains a diversity of ecosystems ranging from the shores of Cook Inlet, across the Chigmit Mountains, to the tundra covered hills of the western interior. The Chigmits, where the Alaska and Aleutian Ranges meet, are an array of mountains and glaciers which include two active volcanoes, Mt. Redoubt and Mt. Iliamna. Lake Clark, 40 miles long, and many other lakes and rivers within the park are critical salmon habitat to the Bristol Bay salmon fishery, one of the largest sockeye salmon fisheries in the world. Numerous lake and river systems in the park and preserve offer excellent fishing and wildlife viewing.

Staff Present: NPS Staff present during visit included Judy Putera, Lee Fink, Leon Alsworth, and Mark Meyer. Park Service volunteers included Kay and Monroe Robinson, and Jerry and Jeannette (last name?). The Project was represented by Chris Monz and Peter D'Luhosch of St. Lawrence University.

Impact and Use Concerns: The 8/04 site visit was conducted in the following locations: Port Alsworth and nearby Lake Kontrashibuna, Lake Lachbuna, Twin Lake, Turquoise Lake, and Telaquana Lake. A variety of hunting, camping, and rafting impacts were observed in the form of tent sites, visitor created trails and semi-permanent hunting camps. There was evidence of soil and vegetative loss as the result of trail creation and widening. Access points to lakes and streams showed similar evidence of impact. Some lakeside campsites contained litter and waste associated with visitor stays. Fire rings and other evidence of campfires were found at both tent site locations and in the camps used by hunters. There was, conversely, evidence of some well informed low impact visitation; campsites on durable substrates such as cobble and rock. These sites showed no sign of trash or waste from visitors.

Conclusions: It was suggested that the Lake Kontrashibuna trail and environs were the most heavily visited and impacted sites within the Park. The impacts to the trails and vistas would be logical locations for visitor counting and impact measurement. The Foothill Lake locations, being more remote, receive less impact and more dispersed use. Repeat visitation and use of the same sites would suggest campsite inventories and GPS /photograph type monitoring. The Twin Lakes Ranger station might be a good location for visitor enumeration and soundscape measurement. Counting and interviewing visitors to the Dick Proenneke Cabin might also provide visitor use information.

APPENDIX 3- GPS, PHOTOGRAPHIC AND MEDIA MAPPER INFORMATION

Spatial:
GPS
Model: Trimble Geo XM
Data Dictionary: Attribute data collected in the field.

Sites	Trails
Location Description	Trail Type
Type of Site	ATV
Campsite	Landing Strip
Day Use	Designated Foot Path
Fishing Access	Unintentional Foot Path
Boat / Aircraft Landing	Date
Condition Class Rating	Time
Size Estimate	Name
Soil / Substrate Type	Comment Box
Gravel	Point Generic
Mineral Soil	Comment Box
Organic Soil	Line Generic
Sand	Comment Box
Cobble	Area Generic
Other	Comment Box
Photo Number	
Date /Time	
Comment Box	

Methods: Spatial data was collected at various sites once satellite connections were sufficient to enable the capture of at least ten points per site. Data was collected post photo collection.

Photographic:
Camera: Nikon Cool Pix 5700
Methods: Once sites had been selected, a photograph was taken. The photo attempted to capture the center of the site and preceded spatial data collection

Software: Post Processing of Spatial Data
Office Pathfinder: Data was downloaded from the Trimble Geo XM. Differential corrections were made via Pathfinder. Data was then exported directly to Trimble Media Mapper
Trimble Media Mapper: Data imported from Office Path Finder was united with a corresponding image via Media Mapper. This was accomplished by the software's ability to synchronize the time signatures of the digital camera and the GPS unit. Photographs and attribute data were assigned to corresponding trails, Sites, Areas, and generic points. The various forms of data were then assembled exported to Arcview.

Arcview 3.3: Shape files representing Photosites, trails, areas, and points of impact were downloaded into ArcView from MediaMapper. These data files were assembled into maps in ArcView with data from various geospatial data sources. The assembled maps and their related files were then burned to disk for presentation.